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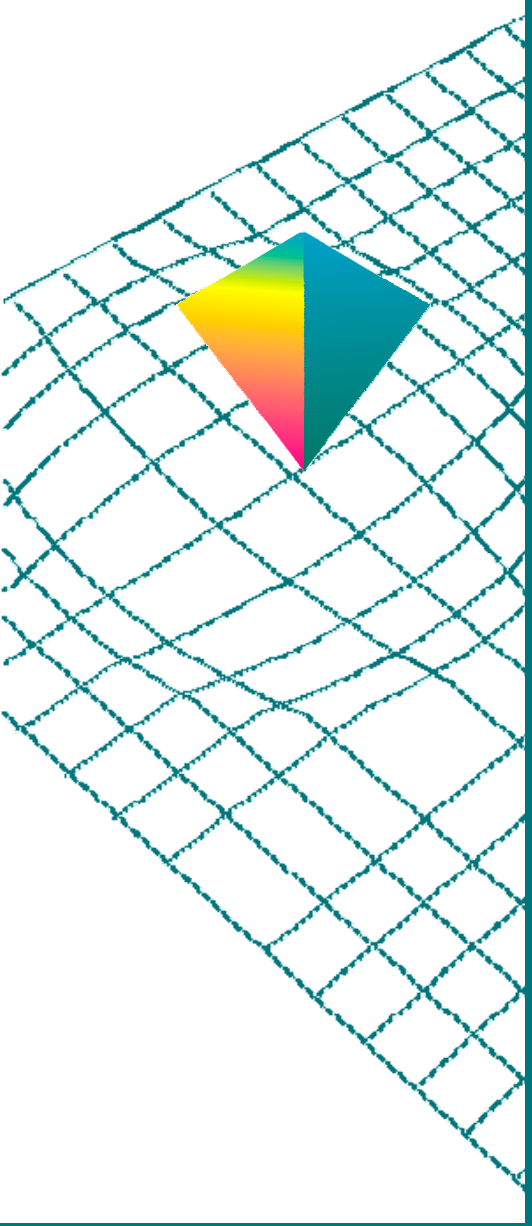

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S. Klyuchkovskyy

The Method of Motion Law Modification of Resonant Manipulation Systems

1. INTRODUCTION

In the robot-building theory and practice the dynamically unloaded Manipulation Systems (MS) are known. The creation of such systems is based on application of self-oscillation properties. Working in autoresonant mode MS must have minimal energy dissipation and must include mechanical energy accumulators – springing elements or (and) flywheels. The kinetic energy of inertial mass is not dissipated by movers or dampers. It is transformed into the potential or kinetic energy of the accumulator. The construction of the Resonant Manipulation Systems (RMS) must be equipped with the controllable catches as this type of MS is a machine of discrete action. The principle of RMS operation consists in accelerating and braking of working rung with a springing element, with fixing working rung in extreme positions by the controllable catches, as well as in compensation of the dissipative losses by the actuator during the time of motion. This device allows tenfold increasing of cyclicity as compared to the traditional scheme with the actuating motor of equal power [1].

There are various RMS structures with different modes of oscillation excitation and attainment of multipositionity (such as the devices with unstable equilibrium of working rung, the devices with ability of accumulator torsional moment reversing, and other with differential scheme). The RMS prototype with accumulator moment reversing designed and realized by author is showed at the Fig. 1.

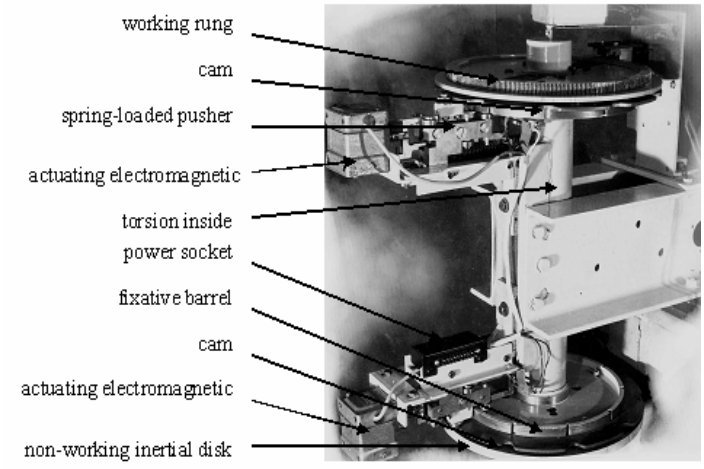

Fig. 1. 10-position rotary RMS prototype with torsion accumulator and two cam-spring electromagnetic actuated devices

Modification of the mode of the motion law presents difficulties for all RMS designs. The law of motion is determined by geometrical and energy-power parameters of the oscillating system. The RMS cycle of motion depends on the actual inertial load. If the inertial load is sufficiently large, the process of transfer of the optimal energy amount from actuator to oscillating system on working stroke and free movement becomes complicated as the average speed is different. Electric motor performance index depends on speed. So, the actuating electric motor control system which has to provide the transmission of the precise portion of energy becomes complicated, accordingly [2].

2. METHOD DESCRIPTION

We propose a new approach to change the law of motion of working rung in purpose to minimize the average speed difference on working stroke and free movement. The insertion of the spring-inertial rotational speed stabilizer into the RMS structure allows this change of mode [3].

The stabilizer is a mechanism with variable masses [4]. It is a rotor with inertial flyweights, which are kinematically connected with the compression spring. The device is constructively similar to the cone centrifugal governor. The specificity of such a device are its settings which provide astatic system properties. It means that the links are being on dynamic balance at steady speed on any position. It allows using it as a mechanical energy accumulator. The stabilizer is capable of recuperating the mechanical energy at steady speed of rotation. The effective rotational moment appears as a result of Coriolis forces action. The Coriolis forces exert on flyweights when stabilizer energy is changing. The stabilizer is characterized by certain level of energy output and low energy losses as in case of RMS.

In case of kinematic connection of the working rung with the stabilizer rotor (see Fig. 2), the stabilizer will collect the energy from RMS accumulator when rotation speed reaches the prescribed limit, and it will return energy after passing over the neutral position.

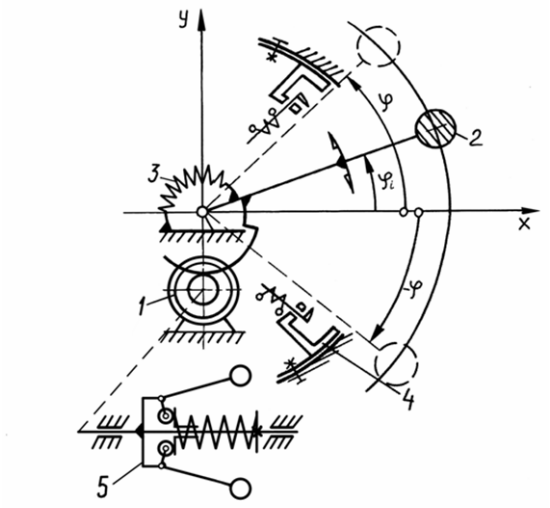

Fig. 2. The design of the elementary RMS with spring-inertial rotational speed stabilizer: 1 – actuating motor; 2 – RMS working rung; 3 – spring accumulator; 4 – controlled catches; 5 – speed stabilizer.

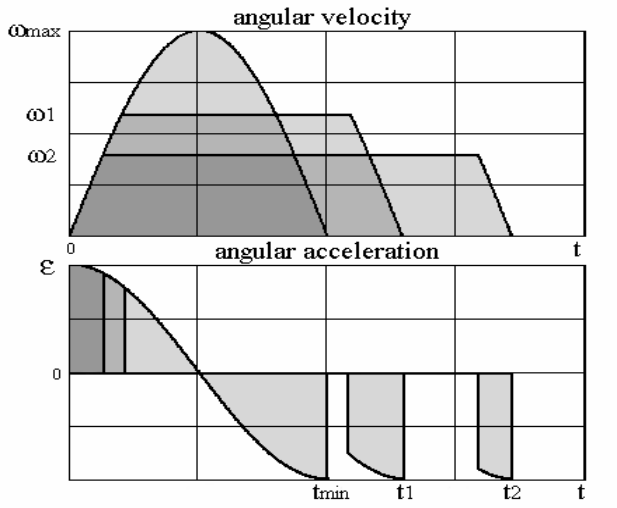

Fig. 3. The RMS law of motion changing by means of speed stabilizer.

Under such conditions the speed will be stabilized on the middle way of working rung trajectory (see Fig. 3).

The synthesis method and the design procedure for the combined RMS & stabilizer device were developed as well as we analysed the influence of the energy-force dimensions and their deflexions on the accuracy of speed stabilizing. The analysis of the influence of the links distributed masses and the analysis of the displacement of lumped masses from the homotopy centerline on the stabilizer's static characteristic deviation from the idealized astatic system characteristic is carried out. The methods of the characteristic's deviation decrease by means of choosing rational parameters and system tuning were developed. Theoretical studies give the ground to state that there is a possibility to reach ±3% of the relative deviation of stabilizer's angular velocity. The energy-power analysis shows that the increase of the stabilizer's energy

intensity is limited by the energy intensity of its spring. So, the energy output of the practicable device comes to tens of kilojoules.

3. CONCLUSION

Proposed combined RMS & stabilizer device offers few advantages:

1. Top speed limitation of the working rung.
2. Speed stabilization in the middle part of the trajectory of the working rung.
3. The essential decrease of the difference between the average speeds and the periods of working stroke and free movement cycles.

Such a non-traditional device can be used as a cycle robot or a carousel driving gear in automatic machines with multiposition rotary table instead of cam or Maltese cross drives. This device provides the advantages of cycle robot, i.e. the possibility of change of movement program by means of the program controller.

Reference:

[1]. Babitsky V. and Shipilov, A., *Resonant Robotic Systems* , Springer-Verlag, Berlin, Heidelberg, New York , 2003, pp 1-174, ISBN 3-540-00334-7.

[2]. Akynfiev T. Resonant Manipulation Systems With Electric Drive. Mashinovedenyje, №6, 1983, pp. 18-23. In Russian.

[3]. Patent of Ukraine №34183A. Angular Speed Control Method and Device. Klyuchkovskyy S. Published 15.02.2001, bulletin №1. In Ukrainian.

[4]. Klyuchkovskyy S. Spring-Inertial Device For Angular Speed Stabilization and Mechanical Energy Accumulating. Mashinoznavstvo, №3, 2001, pp. 33-35. In Ukrainian.

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